Well MW-02

Previous field tests indicate that formation water enters MW-02 at an exceedingly low flow rate, and thus MW-02 is characterized as a "low-yielding" well. The USGS operationally defines a low-yield well as a well that produces substantially less than 1 gallon per minute and for which drawdown occurs such that the well is rapidly pumped dry or for which recovery to at least 90 percent of the pre-pumping water level takes many hours to several days or longer (U.S. Geological Survey, 2006, p. 93). Sampling low-yield wells is not recommended for routine water-quality assessments conducted by the U.S. Geological Survey (USGS) if the water-level recovery after purging a minimum of one complete borehole volume is not 90-percent complete within a 24-hour period; standard USGS practice is to avoid sampling low-yield wells to the extent possible within the constraints of given study objectives (U.S. Geological Survey, 2006, p. 93-94, and 104).

During Phase IV sampling of MW-02 by the USEPA in 2011, the water level in the well declined rapidly because the pumping rate of the dedicated 3-horsepower submersible pump that was installed in the well apparently exceeded the well yield, and it took several days for the water level to recover to pre-pumping levels (U.S. Environmental Protection Agency, 2011a). The USEPA subsequently estimated a yield in MW-02 of about 1 gallon per hour, or about 0.017 gallon per minute (U.S. Environmental Protection Agency, personal communication, 2012). Given a well yield of 1 gallon per hour and given that a single borehole volume of water in MW-02 equals about 510 gallons (U.S. Environmental Protection Agency, 2011a), recovery of the water level in the well following purging of 1 borehole volume would

take considerably longer than 24 hours, depending on the water-level drawdown in the well. The water-level drawdown in MW-02 could be minimized if the well were to be purged at a flow rate closer to the estimated 1 gallon-per-hour yield; in that instance, however, it would take up to 510 hours (21.2 days) to purge one borehole volume from the well. The purge would take longer if three or more borehole volumes of water were removed from the well, in accordance with standard USGS procedures (U.S. Geological Survey, 2006, p. 103). As noted in the USGS Field Manual, the purpose of purging is to reduce chemical and biochemical artifacts caused by the materials and practices used for well installation, well construction, and well development, and by reactions occurring within an open borehole or annular space between a well casing and borehole wall; a long residence time of water within the pump tubing also may compromise sample integrity (U.S. Geological Survey, 2006, p. 92 and 103; Yeskis and Zavala, 2002).

Because of the low yield in MW-02, resulting in long recovery or purge times relative to the standard procedures and recommendations given in the USGS Field Manual, the USGS redeveloped the well during the week of April 30, 2012 in an attempt to increase the well yield. Prior to redevelopment, the well casing was filled with potable water from the City of Riverton to reduce methane concentrations in the well and then the dedicated submersible pump was removed from the well. A down-hole camera was used to examine the well screen, which appeared to be intact; it was not possible to determine the degree to which the screen slots might be plugged. Three hours were spent surging the well using a 4-inch-diameter surge block attached to stainless steel discharge pipe. During well redevelopment precautionary steps

were taken to monitor methane levels from the well and ensure the safety of the field team. After surging, the well was bailed from the bottom for 4.5 hours and from the top of the water column for 11.5 hours. The fluid removed from the bottom had a strong odor.

Redevelopment of MW-02 was completed on May 4, 2012. Subsequent repeated measurements of water-level recovery were made using an electric measuring tape, as attempts to install a pressure transducer near the well bottom were unsuccessful. On the basis of the water-level measurements made in MW-02 on May 4 and May 10, 2012, the USEPA calculated a well yield of approximately 0.65 gallon per hour (U.S. Environmental Protection Agency, personal communication, 2012). The USGS calculated the same well yield based on the available information (table 1). On the basis of the water-level measurements made in MW-02 on May 10 and May 21, 2012, the USGS calculated a well yield of about 0.44 gallon per hour (table 1). These yield estimates are somewhat less than the 1 gallon per hour previously estimated by the USEPA, indicating that the redevelopment effort did not increase the flow of groundwater into the well. Thus, long recovery or purge times can still be expected in MW-02.

Table 1. Well-yield data for MW-02

First water-level measurement		Second water-level measurement		
Date	Depth to water (feet below land surface)	Date	Depth to water (feet below land surface)	Well yield (gallons per hour)
5/4/2012	955.03	5/10/2012	817.29	0.65
5/10/2012	817.29	5/21/2012	641.34	0.44

Alternative sampling techniques were considered for MW-02, such as the use of a low-flow pump with and without a packer system. These and other techniques are reported in the literature and have been used to maximize yield and alleviate the problems associated with

long recovery or purge times (Puls and Barcelona, 1996; Shapiro, 2001; U.S. Geological Survey, 2006, p. 108; ASTM, 2007). Those techniques, however, would have to be tested at MW-02 to determine whether they could be applied successfully at MW02 (Shapiro, 2002). Testing alternative sampling methods and evaluating the results are beyond the intended scope of this project, in which the USGS was to implement its standard procedures for routine assessments of groundwater quality. Were the scope of the project to be expanded, it would not be possible to complete sampling and evaluate the results by the mid-September report deadline.

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